Welcome to
NASA Applied Remote Sensing Training Program (ARSET)
Webinar Series

Introduction to Remote Sensing Data for Land Management

Course Dates: Every Tuesday, May 20-June 17
Time: 9-10AM EDT/EST

ARSET

Applied Remote SEnsing Training

A project of NASA Applied Sciences

Outline

- About ARSET
- ARSET Course Structure and Objectives
- Global Land Management Issues
- Overview of NASA Remote Sensing Data for Land Resources Management

Applied Remote SEnsing Training (ARSET)

A NASA Applied Sciences Capacity Building Program

NASA Earth Science
Applied Sciences Program

Applications to Decision Making: Eight Thematic Areas

Agricultural Efficiency

Air Quality

Climate

Disaster Management

Ecological Forecasting

Public Health

Water Resources

ARSET

Objectives

- Provide end-users with **professional technical workshops**
- Build long term partnerships with communities and institutions in the public and private sectors.

Online and hands-on courses:

- **Who:** policy makers, environmental managers, modelers and other professionals in the public and private sectors.

  Where: U.S and internationally
- **When**: throughout the year. Check websites.
- Do NOT require prior remote- sensing background.
- Presentations and hands-on guided computer exercises on how to access, interpret and use NASA satellite images for decision-support.

NASA Training for California Air Resources Board, Sacramento, CA December 2011

ARSET

ARSET has completed webinars and workshops on Air Quality and Water Resources both nationally and internationally.

Air Quality website:
http://arset.gsfc.nasa.gov/airquality

Water Resources website:
http://arset.gsfc.nasa.gov/water

Attendees of the NASA water resources training at the University of Oklahoma on June 19-20, with course instructors Amita Mehta and Ana Prados. Preliminary end-user feedback included a) interest in follow-on advanced/online courses and b) additional topics in land products, e.g. ET and Landsat.

Who Can Benefit from ARSET Courses?

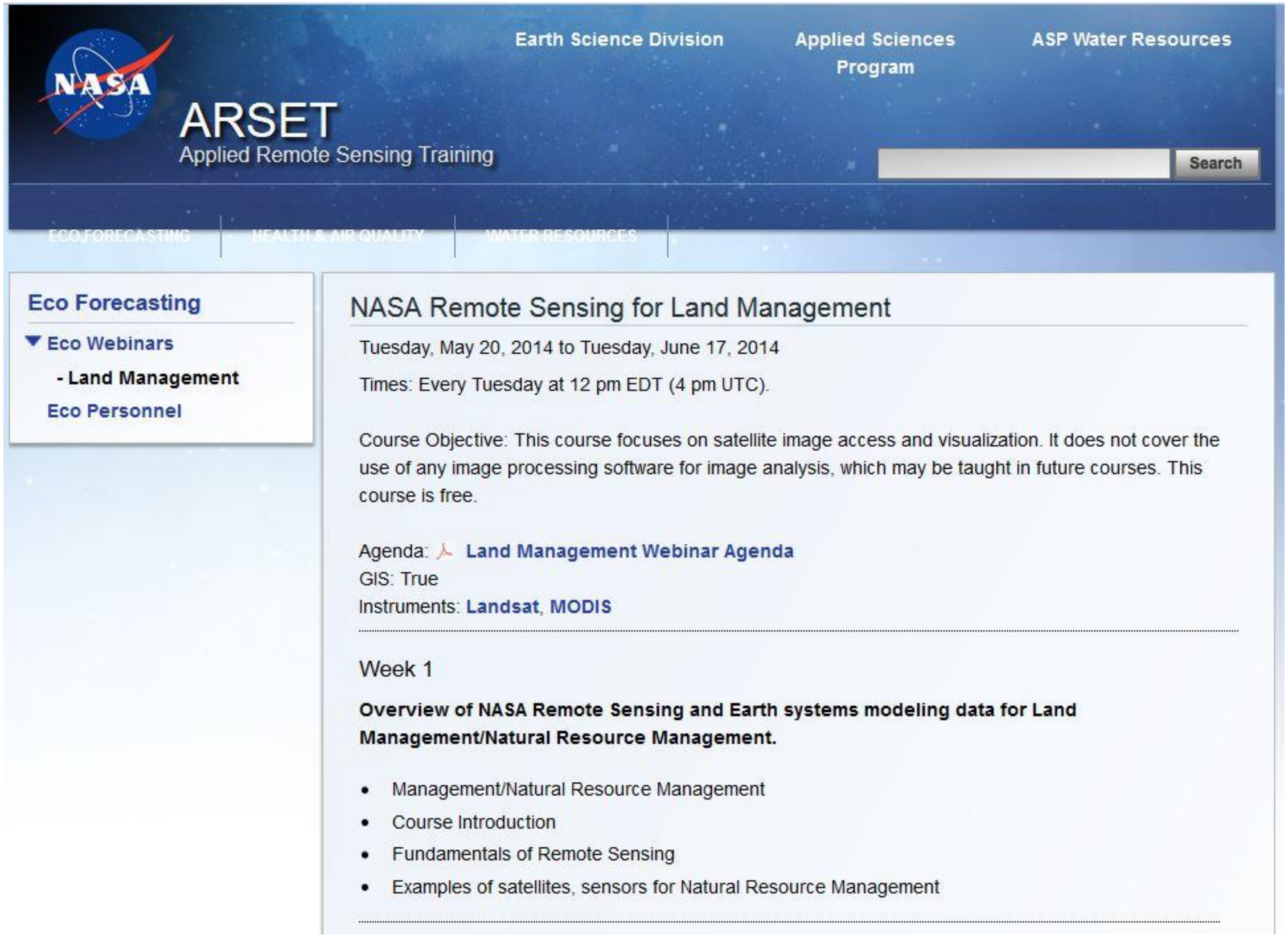
- **Public Sector:** Local, state, federal, international regulatory agencies, project managers, health and disaster management agencies, World Bank, United Nations

- **Private Sector:** Tribal nations, NGOs, consultants, industry, and other organizations involved in capacity building

- **Scientists/Technical Experts:** Ecologists, geologists, modelers, biologists, etc..

ARSET Land Resource Management

http://arset.gsfc.nasa.gov/eco/webinars/land-management


Earth Science Division | Applied Sciences Program | ASP Water Resources

ARSET
Applied Remote Sensing Training

Search

ECO FORECASTING | HEALTH & AIR QUALITY | WATER RESOURCES

Eco Forecasting

- **Eco Webinars**
  - **- Land Management**
- **Eco Personnel**

NASA Remote Sensing for Land Management

Tuesday, May 20, 2014 to Tuesday, June 17, 2014

Times: Every Tuesday at 12 pm EDT (4 pm UTC).

Course Objective: This course focuses on satellite image access and visualization. It does not cover the use of any image processing software for image analysis, which may be taught in future courses. This course is free.

Agenda: **Land Management Webinar Agenda**
GIS: True
Instruments: **Landsat**, **MODIS**

Week 1

Overview of NASA Remote Sensing and Earth systems modeling data for Land Management/Natural Resource Management.

- Management/Natural Resource Management
- Course Introduction
- Fundamentals of Remote Sensing
- Examples of satellites, sensors for Natural Resource Management

Your Course Instructors

- Cindy Schmidt (ARSET): cynthia.l.schmidt@nasa.gov
- Amita Mehta (ARSET): amita.v.mehta@nasa.gov
- Guest Speaker: Jennifer Dungan (VIIRS)
- Esther Essoudry (ARSET)
- Brock Blevins (ARSET)

General inquiries about ARSET: Ana Prados (ARSET)
aprados@umbc.edu

Course Structure

Course Objectives

- **Provide overview of land management issues**
- **Introduce web-tools for data access, analysis and imaging**
- **Show examples of data applications**
- **Prerequisite for advanced ARSET trainings**

Webinar Course Structure

- **One lecture per week – every Tuesday from 20 May to 17 June (9-10 AM EDT/EST)**
- **Webinar presentations can be found at: http://arset.gsfc.nasa.gov/eco/webinars/land-management**
- **Two assignments (after Week 2 and Week 4)**
- **Q/A: 15 minutes following each lecture and/or by email (cynthia.l.schmidt@nasa.gov)**

Certificate of Completion (upon request):

You must attend all 5 live sessions

You must submit 2 homework assignments

For Webinar Recording Link:

Contact: Marines Martins

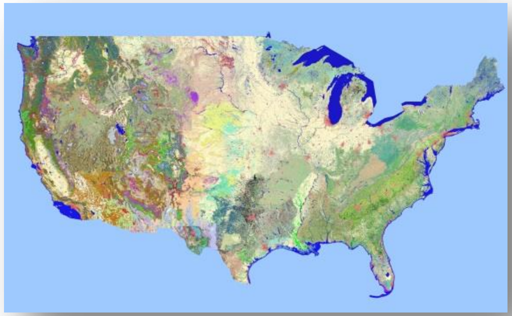
Email: marines.martins@ssaiha.com

Course Outline

Week 1

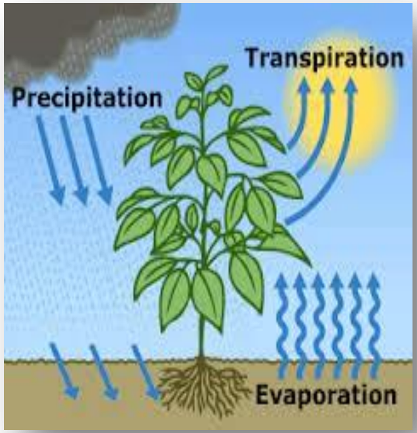
Intro. & Background: Satellite Remote Sensing

Week 2



Land Cover Mapping/Web tools for data access

Week 3



Soil Moisture and Evapotranspiration

Week 4

Change Detection

Week 5

Web tools for data access/Importing data into GIS

Week 1 (20 May 2014)

Overview of NASA Remote Sensing and Earth Systems Data for Land Resources Management

- Global land resources and land management issues
- NASA Earth science research questions and monitoring ecosystem change
- Advantages and disadvantages of remote sensing
- Fundamentals of remote sensing
- NASA satellites and sensors for land management

Global Land Resources

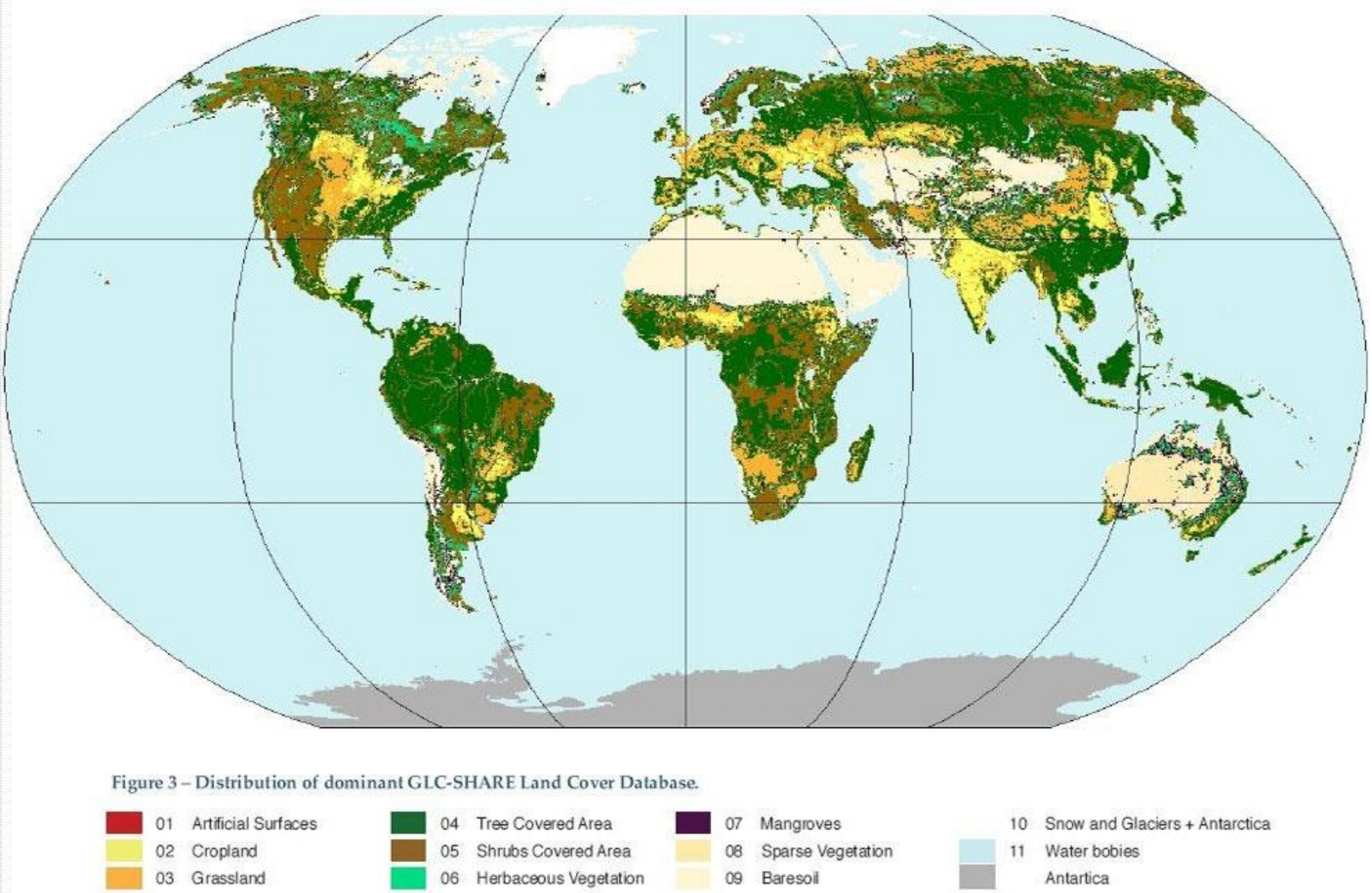


Figure 3 – Distribution of dominant GLC-SHARE Land Cover Database.

Land Cover	%
Tree cover	27.7
Bare soils	15.2
Grasslands	13
Croplands	12.6
Snow and glaciers	9.7
Shrub-covered	9.5
Sparse vegetation	7.7
Inland water bodies	2.6
Herbaceous vegetation	1.3
Artificial surfaces	0.6
Mangroves	0.1

Source: FAO Global Land Cover SHARE database
http://www.glcn.org/databases/lc_glcshare_en.jsp:

Global Land Resources: Critical Issues

- Food production
  - Growing populations
  - Less natural resources
  - Changing climate
- Plant and animal species
  - Habitat loss
  - Declining biodiversity
  - Changing climate

Source: www.icid.org

Source: polarbearsinternational.org

Source: naturemappingfoundation.org

Land Management Issues

- Treeline/ecotone changes
- Invasive species
- Desertification
- Deforestation
- Urban growth
- Crop management
- Wildfire
- Loss of biodiversity
- Habitat loss

Source: nps.gov

Yellow star thistle

Source: NASA Earth Observatory

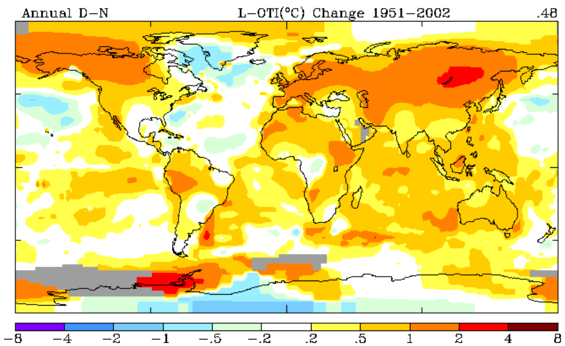
MODIS images of Rondonia in western Brazil.

NASA's Earth Science Research Questions

- How is the global Earth system changing?
- What are the primary causes of change in the Earth System?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences of changes in the Earth system for human civilization?
- How well can we predict future changes to the Earth system?

Monitoring Ecosystem Change

- NASA Earth science questions with respect to ecosystems:
  - How are global ecosystems changing?
  - How do ecosystems respond to and affect global environmental change and the carbon cycle?

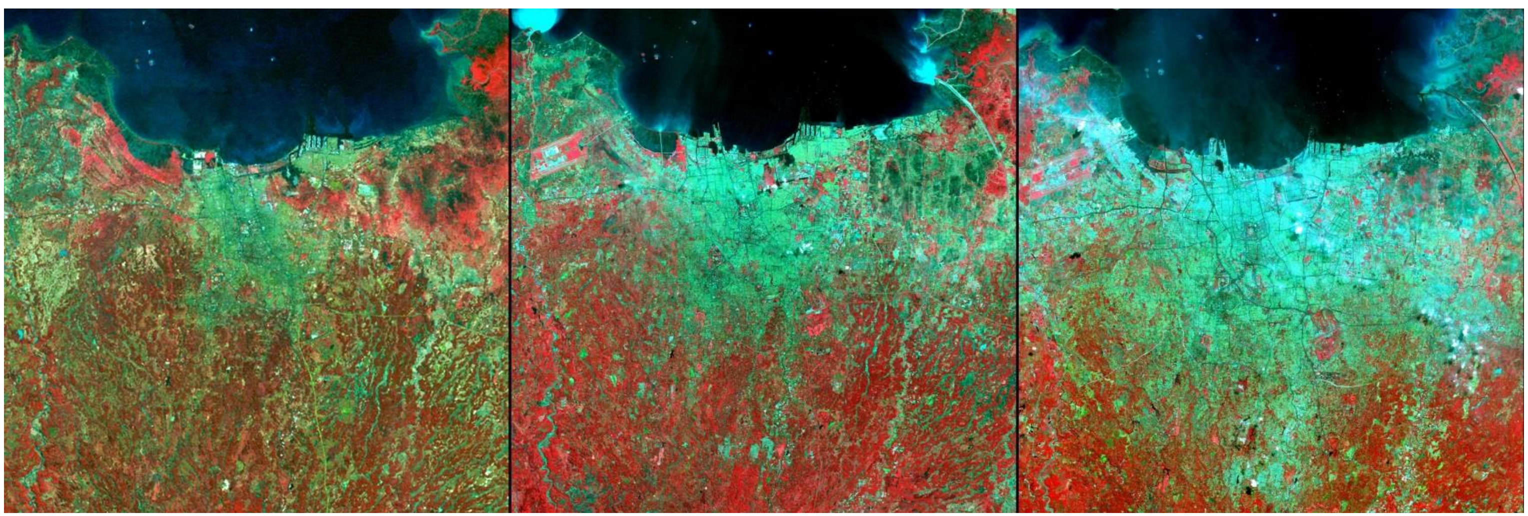


- Climate change:
  - Although climate change is a global phenomenon….
  - The effects of climate change on ecosystems are local and heterogeneous

Monitoring Ecosystem Change with Satellite Imagery

- Identify land cover
- Monitor change over time

While land cover can be observed on the ground or by airplane, the most efficient way to map it is from space.



Source: NASA Earth Observatory

Urban growth from 1976, 1989 to 2004 in Jakarta, Indonesia

Advantages and Disadvantages of Remote Sensing Observations for Land Management

Plot-based Measurements

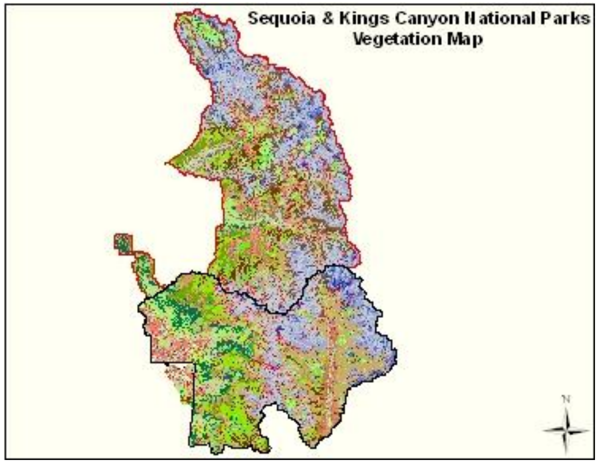
- Example: US Forest Service Forest Inventory Analysis (FIA)
  - Very detailed information for each plot
  - Non-uniform spatial and temporal coverage
  - Cannot get exact locations of plots

Remote Sensing Observations

- Provide information where there are no ground-based measurements

- Provide globally consistent observations

- Disadvantages:
  - Does not provide high level of detail at the ground level
  - Cannot detect landcover under canopy



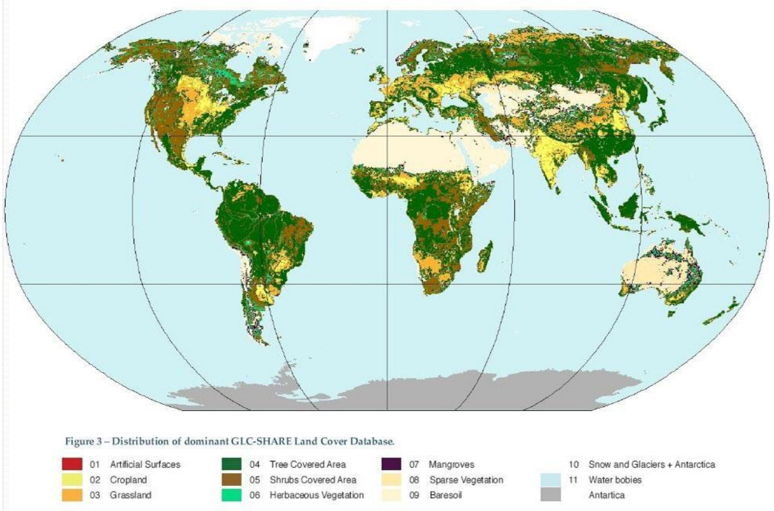


Figure 3 – Distribution of dominant GLC-SHARE Land Cover Database.

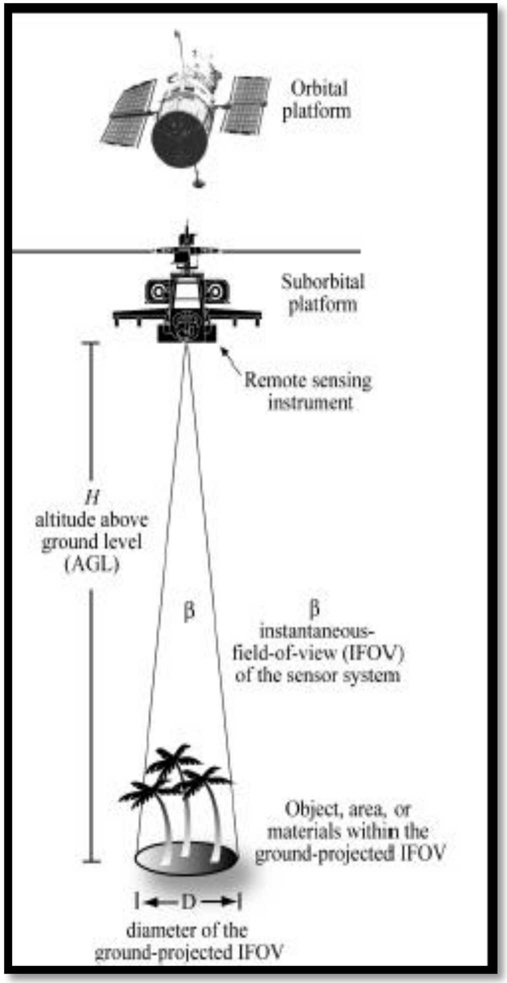
Fundamentals of Remote Sensing

Remote Sensing

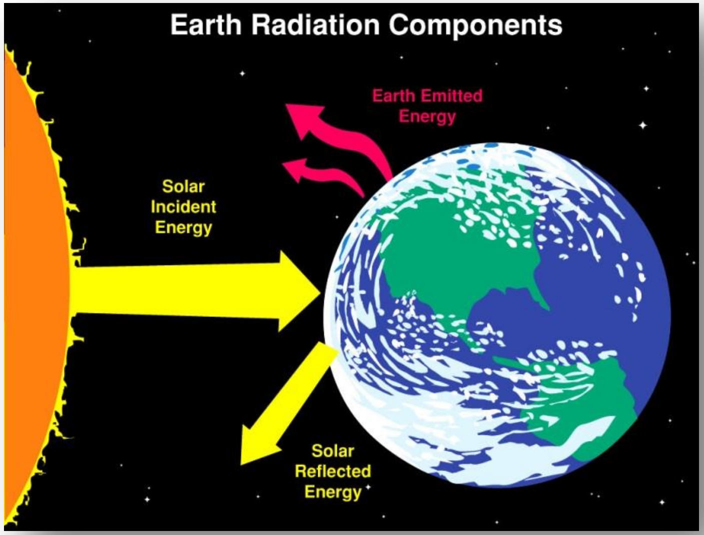
Measurement of a quantity associated with an object by a device not in direct contact with the object

- Platform depends on application
- What information? how much detail?
- How frequent

Satellite Remote Sensing: measuring properties of the earth-atmosphere system from space



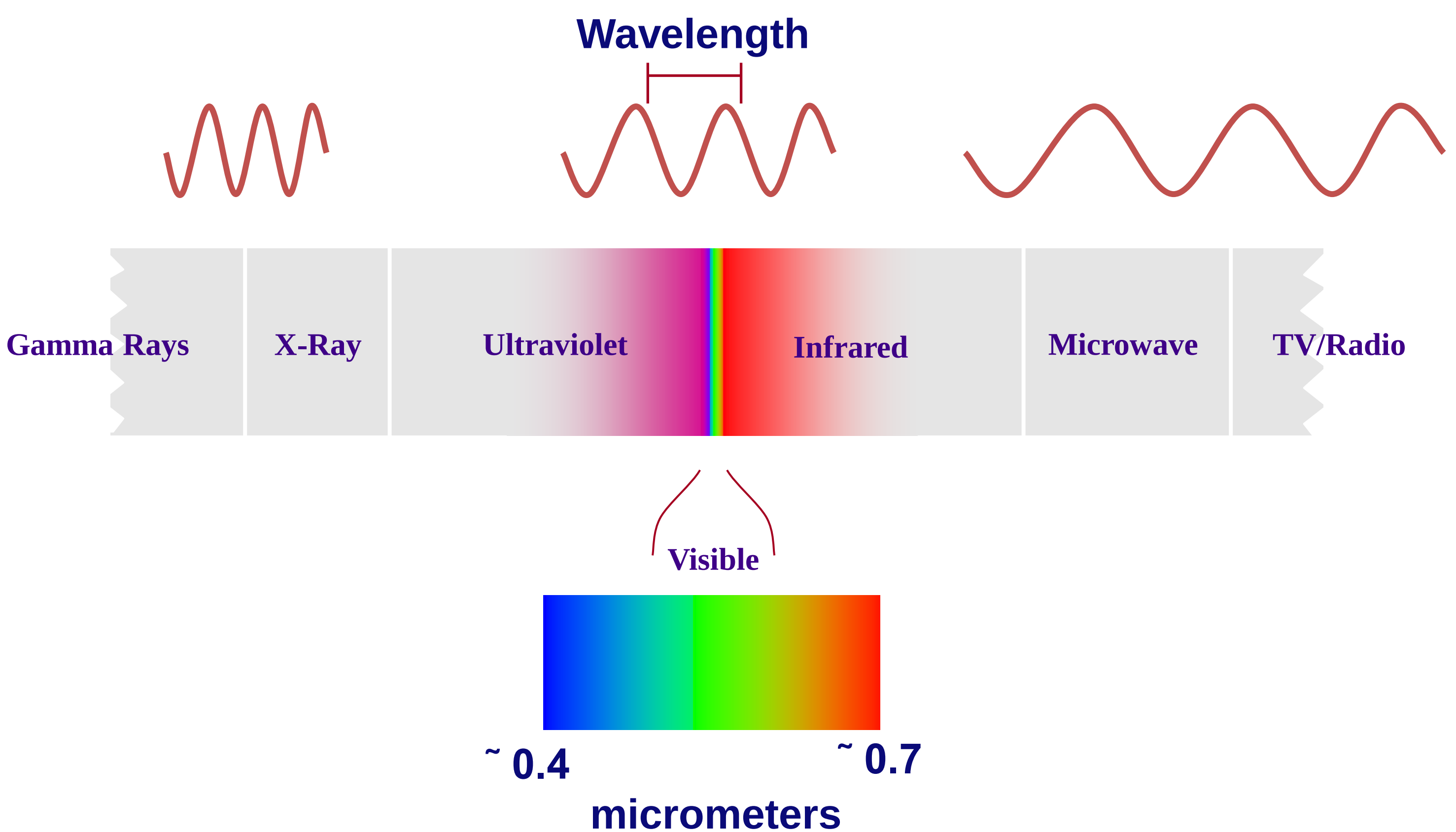
Satellites carry instruments or sensors which **measure electromagnetic radiation** coming from the earth-atmosphere system



Electromagnetic Radiation

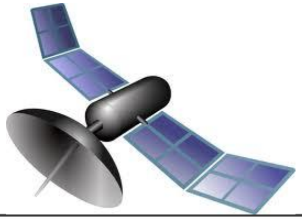
Earth-Ocean-Land-Atmosphere System :
- reflects solar radiation back to space
- emits Infrared radiation and Microwave radiation to space

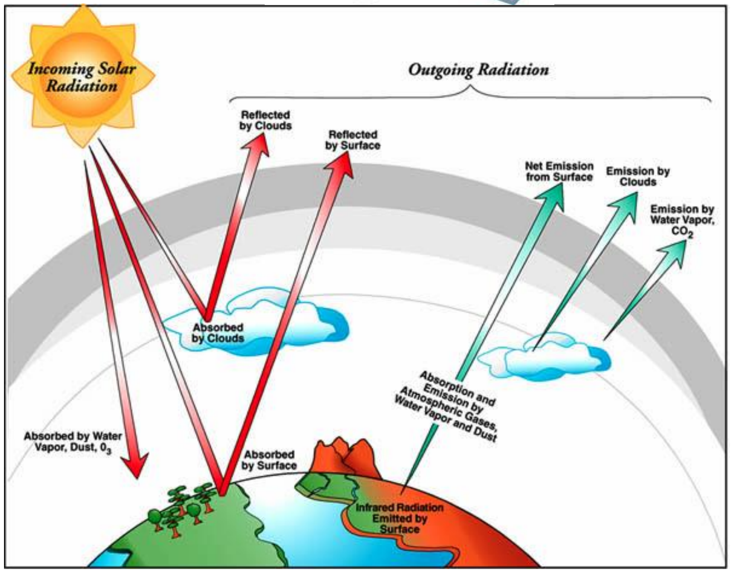
Electromagnetic Spectrum



Satellite Remote Sensing

Measuring Properties of Earth-Atmosphere System from Space

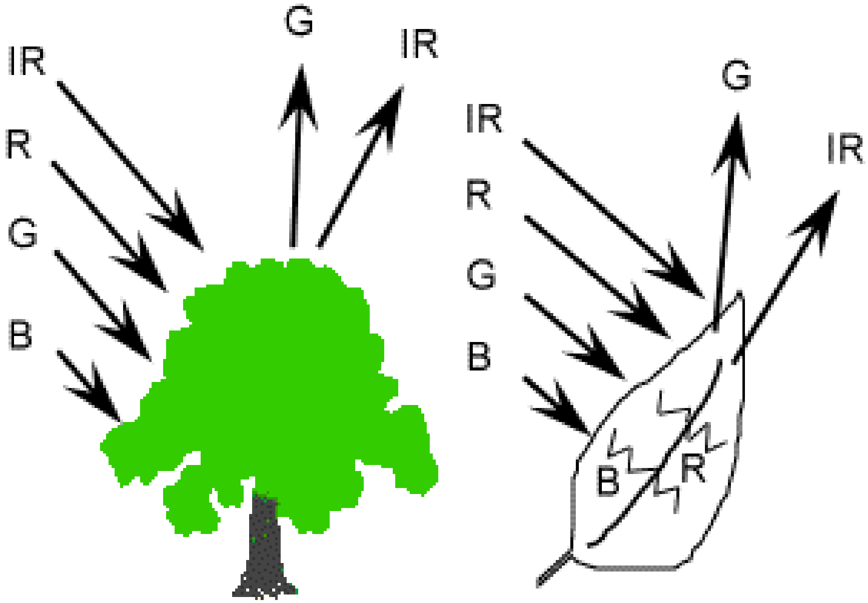




- The intensity of reflected and emitted radiation to space is influenced by the surface and atmospheric conditions

- Thus, satellite measurements contain information about the surface and atmospheric conditions

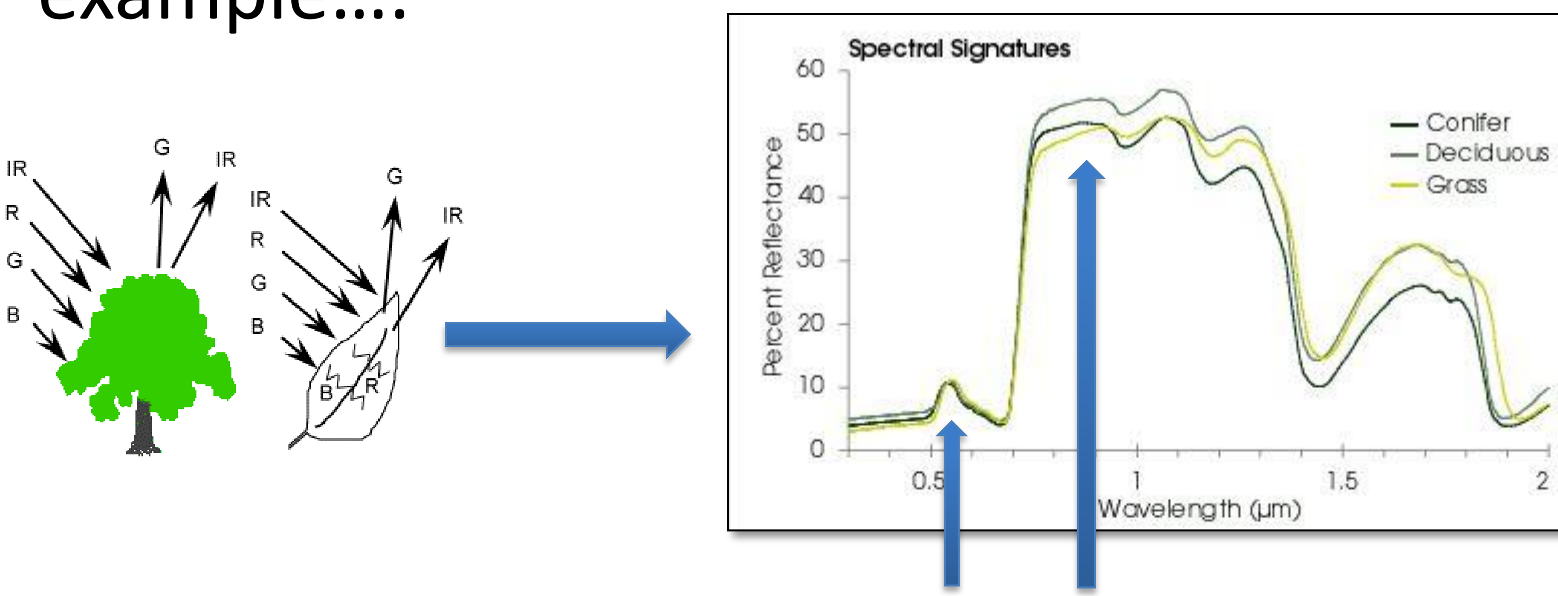
Electromagnetic Energy: Example



- Example: Healthy, green vegetation <u>absorbs</u> Blue and Red wavelengths and <u>reflects</u> Green and Infrared

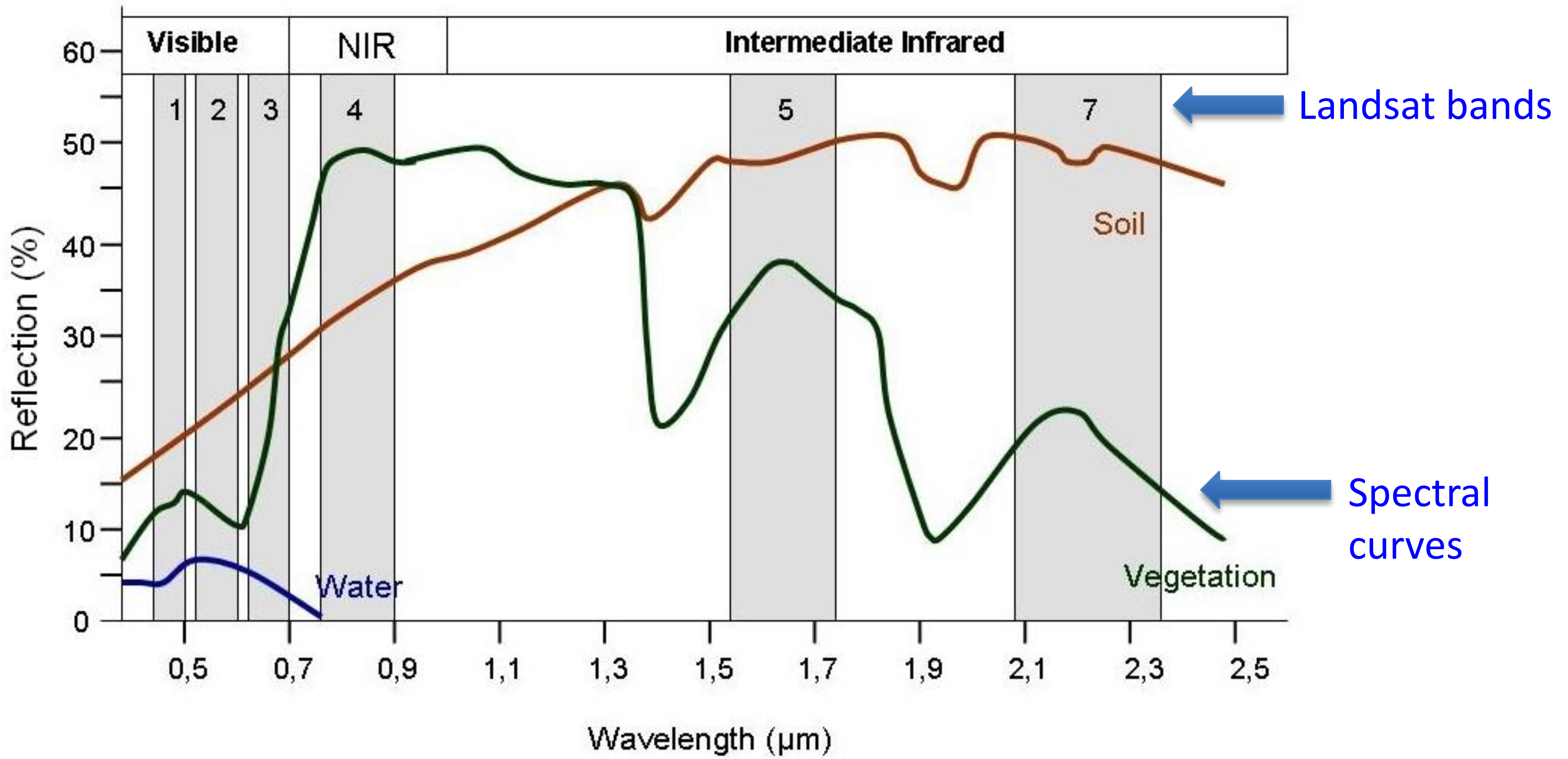
Spectral Signatures

- Every kind of surface has it's own spectral signature
- Going back to the healthy vegetation example….



Green Near-Infrared (IR)

Bringing it all together…..



Satellite Remote Sensing Observations

What we need to know:

- Instruments/sensors and types

- Types of satellite orbits around the earth

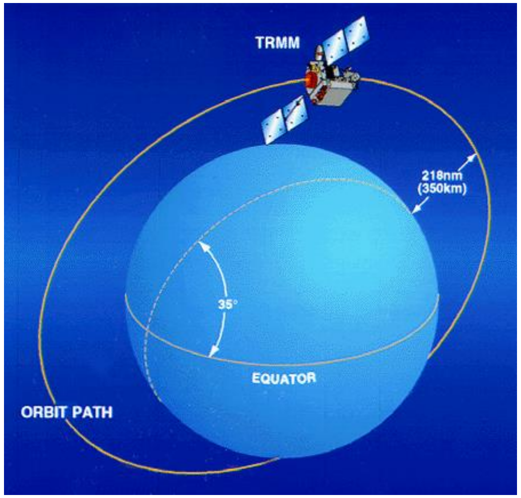
  Spatial and Temporal Resolution and Spatial Coverage

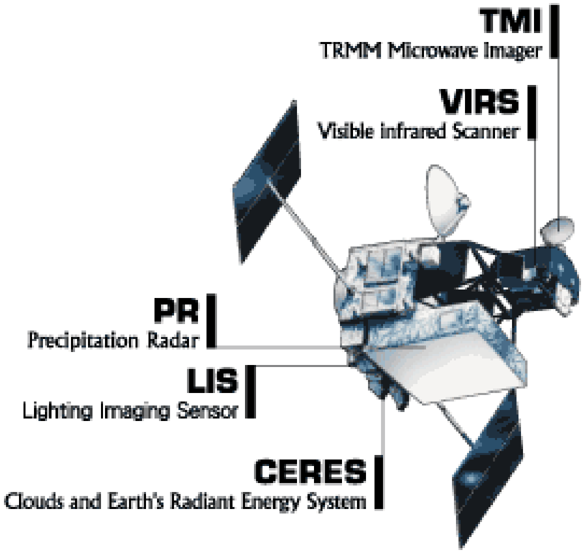
- Geophysical quantities derived from the measurements

  quality and accuracy of the derived quantities

  availability, access, format

  applications and usage





Satellite Sensors

Type of Sensors

Spectral Resolution

Radiometric Resolution

Spatial Resolution

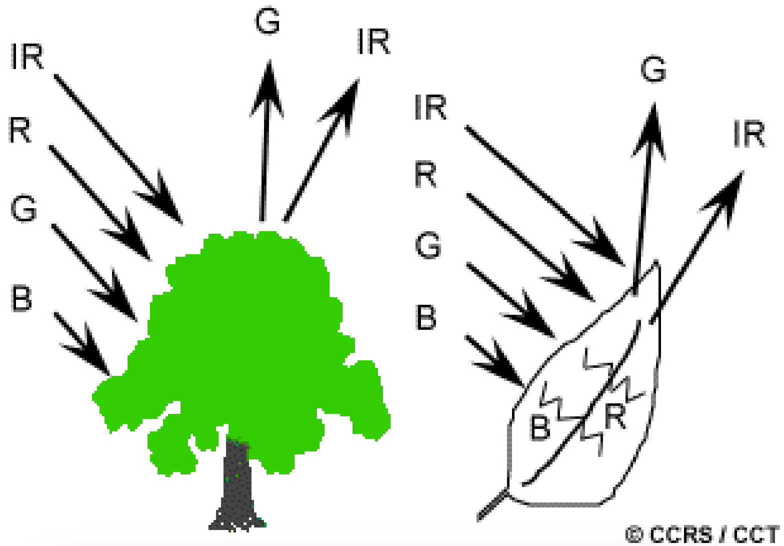
Satellite Sensors

Passive remote sensors

Measure radiant energy

Reflected or emitted by the

earth-atmosphere System



Examples:

Landsat, MODIS

Satellite Sensors

Active remote sensors 'throw' beams of radiation on the earth-atmosphere system and measure 'back-scattered' radiation

The back-scattered radiation is converted to geophysical quantities

Advantages:

- Can be used day or night
- Can penetrate cloud cover

Disadvantages:

- Challenging to process
- Some available only from aircraft

Examples: Radar, LIDAR

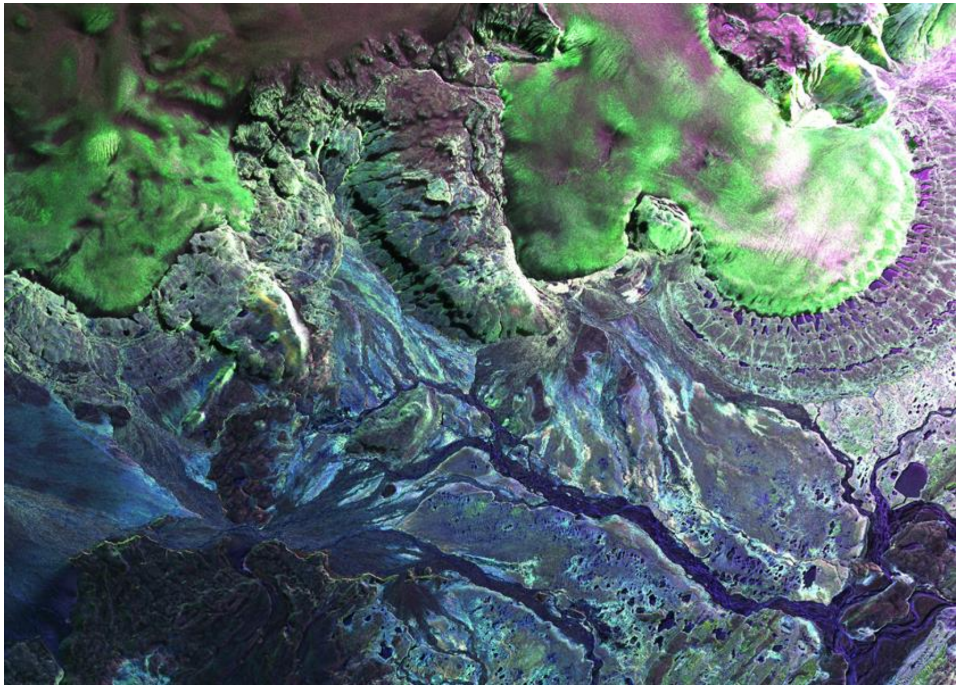


Image courtesy of uavsar.jpl.nasa.gov

UAV SAR image of a glacier in Hofsjokull, Iceland (June 12,2009). The blue areas are bare ground surfaces and the green areas are ice.

Spatial and Temporal Resolution of Satellite Measurements

- Depends on the satellite orbit configuration and sensor design

- **Temporal resolution:**

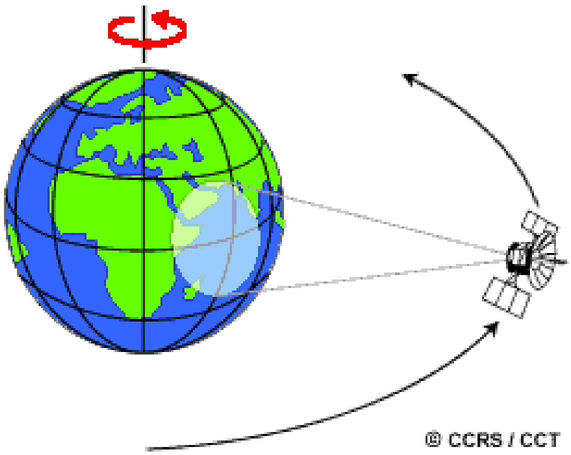
  How frequently a satellite observes the same area of the earth

- **Spatial Resolution:**

  Decided by its pixel size -- pixel is the smallest unit measured by a sensor

Types of Satellite Orbits

Geostationary orbit

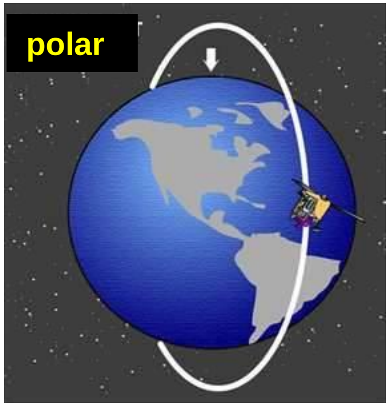


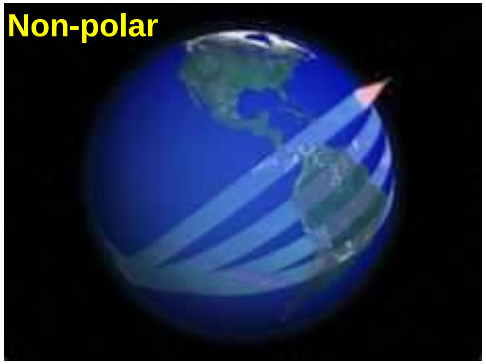
Satellite is at ~36,000 km above earth at equator. Same rotation period as earth's. Appears 'fixed' in space.

- Frequent measurements
- Limited spatial coverage

Examples: weather or communications satellites

Low Earth Orbit (LEO)





Circular orbit constantly moving relative to the Earth at 160-2000 km. Can be in Polar or non-polar orbit

- Less frequent measurements
- Large (global) spatial coverage

Polar orbit examples: Landsat or Terra satellites

Spatial Resolution

- Spatial resolution refers to the detail discernable in an image by a pixel

Sensor	Spatial Resolution
Digital Globe (and others)	1-4 m
Landsat	30 m
MODIS	250m-1km

Spatial Resolution

1 meter 10 meter 30 meter

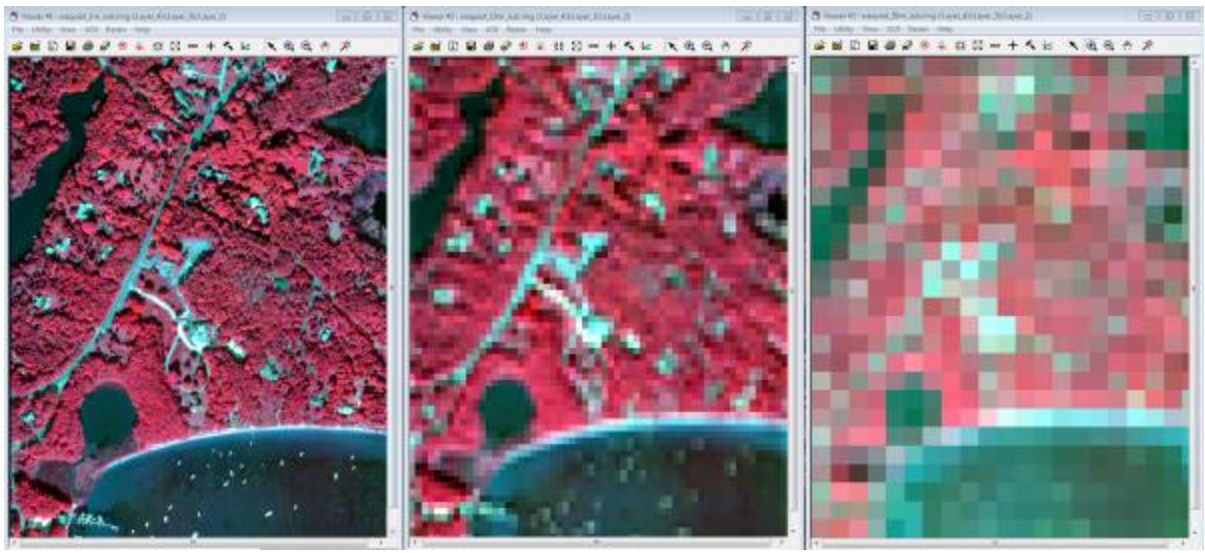
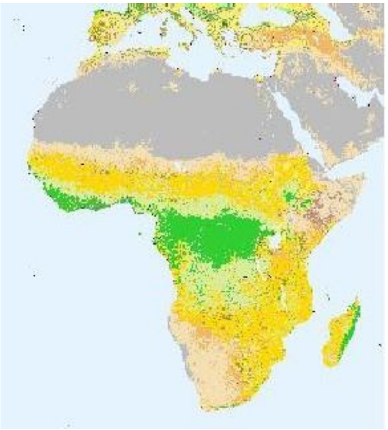


Image courtesy of www.csc.noaa.gov

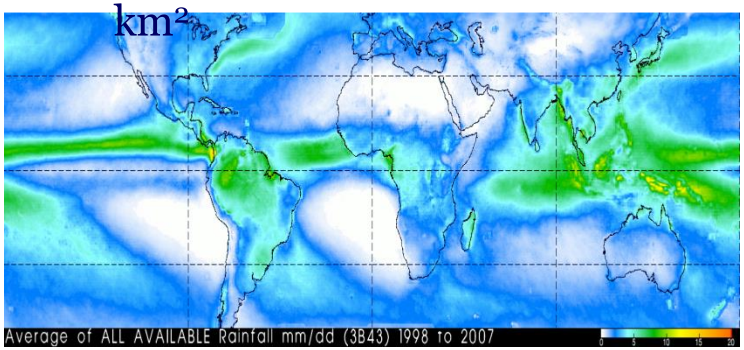
NASA Satellites Measurements with Different Spatial Resolution

Landsat Image of Philadelphia
Spatial resolution: 30 m

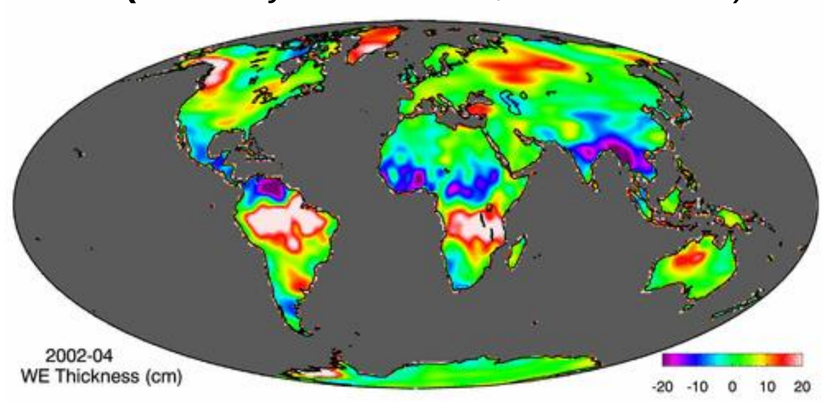
Land Cover from Terra/MODIS:
Spatial resolution: 1 km²
(From: http://gislab.jhsph.edu/)



Rain Rate from TRMM
Spatial resolution: 25 km²



Terrestrial Water Storage Variations from GRACE: Spatial resolution: 150,000 km² or coarser **(**Courtesy: Matt Rodell, NASA-GSFC)



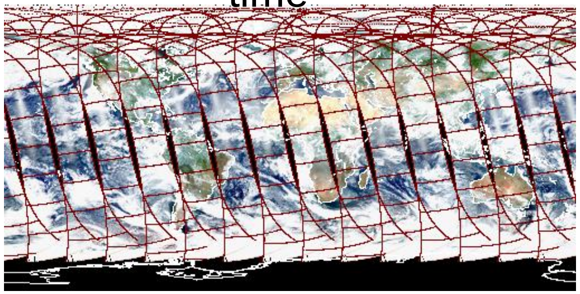
Spatial Coverage and Temporal Resolution

Polar orbiting satellites: global coverage - but one to two or less measurements per day per sensor. Orbital gaps present. Larger Swath size, higher the temporal resolution.

Non-Polar orbiting satellites: Less than one per day. Non-global coverage. Orbital gaps present. Larger Swath size, higher the temporal resolution.

Geostationary satellites: multiple observations per day, but limited spatial coverage, more than one satellite needed for global coverage.

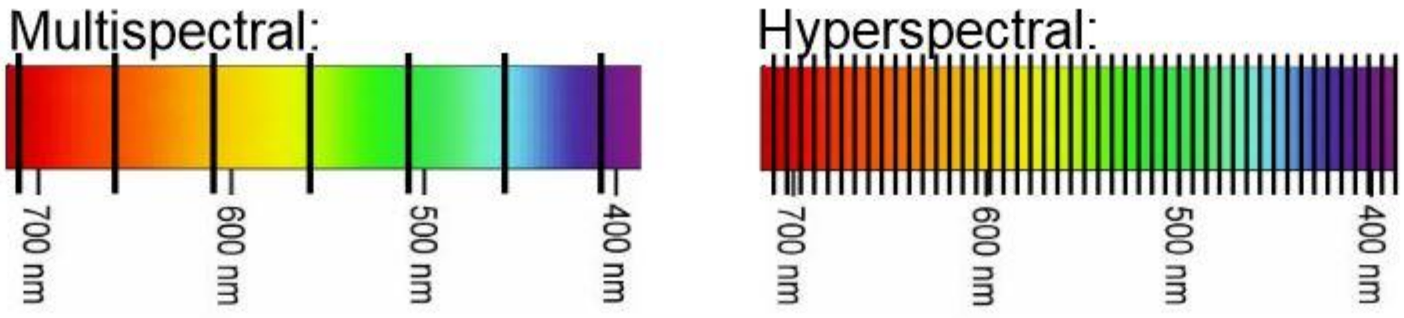
Aqua ("ascending" orbit) day time



TRMM Image

GOES Image

Spectral Resolution: The number and width of spectral channels. More and finer spectral channels enable remote sensing of different parts of the atmosphere



Radiometric Resolution: Remote sensing measurements represented as a series of digital numbers – the larger this number, the higher the radiometric resolution, and the sharper the imagery.

Remote Sensing Observations : Trade Offs

- It is very difficult to obtain extremely high spectral, spatial, temporal and radiometric resolution at the same time
- Several sensors can obtain global coverage every one – two days because of their wide swath width
- Higher spatial resolution polar/non-polar orbiting satellites may take 8 – 16 days to attain global coverage
- Geostationary satellites obtain much more frequent observations but at lower resolution due to the much greater orbital distance
- Large amount of data with varying formats
- Data applications may require additional processing, visualization and other tools

NASA Satellites and Sensors for Land Management

NASA Satellites for Land Management

Landsat (1972-present)
Terra (1999-present)
Aqua (2002-present)
GRACE (2002-present)
EO-1 (2000-present)

Not shown:
Suomi NPP (VIIRS)
(partnership between NASA, NOAA and DOD)

NASA Satellite Instruments for Land Resources Management

Satellite	Sensor(s)	Spatial Resolution
Landsat 4 and 5	Landsat TM	30m (120 m thermal band)
Landsat 7	Landsat ETM+	15m panchromatic, 30m multispectral, 60m thermal
Landsat 8 (LDCM)	Operational Land Imager (OLI), Thermal Infrared Sensor (TIRS)	15m panchromatic; 30m multispectral; 100m thermal
Terra, Aqua	MODerate Resolution Imaging Spectroradiometer (MODIS)	250m - 8 km
Terra	ASTER	15-90m
EO-1	Hyperion, Advanced Land Imager (ALI)	10-30m
Suomi NPP	Visible Infrared Imager Radiometer Suite (VIIRS)	375-750m

Products Derived from NASA Satellites for Land Resource Management

- Land cover maps
  - Many different sources: regional, national and global
  - Single snapshot in time
  - Land cover classification varies
- Vegetation Indices (NDVI, EVI, SAVI, etc.)
  - Many different sources at different spatial resolutions
  - Can get time series
- Other (Fire perimeters, burn severity)
  - A few sources at different spatial resolutions
- Change Detection
  - New methods are using the freely available Landsat time series to get annual (or monthly) change

Coming up next week!

Week 2 (27 May 2014)

Overview of Land Cover Mapping

In the coming weeks, please feel free to suggest specific demonstrations of portals or use of data that you might be interested in for WEEK 5.

Thank You!

Cindy Schmidt
Cynthia.L.Schmidt@nasa.gov